After retaining this length for some distance they gradually get shorter, till near the top of the nose they have dwindled to a length of 1½ inches. On the inner side of this principal set of baleen, and close to the palate, a smaller fringe is observable, of which the baleen, where longest, reaches the length of 1½ inch, by a breadth of 1 inch.

This inner fringe is separated by a well-defined line of division from the larger baleen, and shows, at the same time, three or more lines of division, so that the base has quite a reticulated appearance.

That the larger and smaller series are quite distinct from each other is well exhibited on the base, because, although in some parts the line of the large baleen is continued into the inner fringe, in others this is not the case, the inner baleen beginning on the line of division between the baleen plates of the larger series.

ART. XIX.—*Notes on some Specimens of migratory* Salmonidæ.

By W. ARTHUR, C.E.

[*Read before the Otago Institute, 24th August,* 1880.]

Plates IV. and V.

BEFORE referring specially to the individual specimens I have been able to secure, I may perhaps be permitted to remind you that the study of the Salmonidæ is that of the most difficult and perplexing branch of ichthyology. This is due to the following circumstances:—the close relation between some of the species; the numerous varieties of the same species; the confusion arising from the same fish being differently named in different localities, or erroneously named; and lastly, the want of completeness and precision of description in the writings of many who have undertaken to describe fish.

General remarks on well known species.

To illustrate in a general way the many varieties which occur of the same species, I would direct your attention to the species *S. salar*, *S. trutta*, and *S. fario*, of the British genus *Salmo*.

I have seen individuals of the species *S. salar*—the true salmon—from the Tay, the Tweed, Solway, Clyde and tributaries, Awe, Orchy, Lochy, Ness, Dee (Aberdeenshire); from several English rivers, as the Tyne, Dee, etc., and from the west of Ireland. These were all specifically the same fish, yet possessing individual characteristics sufficient to indicate and distinguish the fish of one river from those of any of the others. For

beauty of colouring, symmetry of form, and every good point, the Tay salmon I regard as unsurpassed—he is the king of fishes! The head is well formed, sharp and of moderate size, the lower jaw in the males having a prominent hook; the body full and robust, with arched back and full belly, all covered with a mass of burnished silvery scales, a few black *x*-shaped spots above the lateral line mostly, and the tail broad and square, or slightly emarginate. In weight, too, they excel, having been taken as heavy as 60 and 70 lbs.—while it is a common event to kill 30 lb. salmon in Loch Tay with rod and spinning lures in February or March. I have seen Irish salmon in the London market as high as 56 lbs. in weight, but they were not equal in appearance to the Tay fish, being dull in colour and rather coarse looking.

The salmon of the other Scotch rivers enumerated, I would describe generally as rounder in the head and longer relatively in the body than those of the Tay. Yet none differ so much from the latter in external appearance as the salmon of the Awe and Orchy rivers. When fishing these streams in August or September, I have found the salmon dark in colour and possessing a most extraordinary and characteristic head. The skull or cranium is low, the head elongated, and the snout so much produced as to resemble very much that of a pig! An Awe salmon could be identified anywhere by its head.

The weight of salmon (*S. salar*), other things being equal, appears to have some relation to the latitude and the size of the rivers which it frequents. Thus, for example, the Forth and Tay salmon attain a greater average and maximum weight than those caught in the small rivers of the Hebrides, which run about 7 lbs. and do not exceed 12 lbs. It would seem as if the higher the latitude and smaller the rivers, the smaller the fish.

A good deal of imagination has been indulged in trying to find a function for the hook on the lower jaw of the male fish. It was believed at one time to be used in the excavation of the "ridd" in which the female deposits her spawn. But such is not the case, at all events there is no case on record of the male having been seen so occupied; for many observers have watched the female, and state how they have seen her roll on to her side and lash the water with her tail, and so gradually form the hollow or "ridd" in the gravel, wherein she forthwith deposited her ova. Others again fancied that the hook was the weapon provided by nature for the males to do their fighting with rival males during the spawning season. I scarcely think this can be correct either; for the teeth being really the weapons of offence and defence, it follows that the hook, which is at the snout, must in biting hinder the teeth from doing so much injury as otherwise they would inflict.

Its design therefore seems rather to indicate the prevention than the infliction of injuries. Its alleged enlargement during the spawning season, must be the result of a sympathetic action due to the peculiar condition of the male at that period.*

The *salar*, in common with the sea-trout and brown trout, is not found native in any waters in the southern hemisphere. Also, it is not met with further south than 40° to 42° of north latitude.

Then among *sea-trout*, we have of species *S. trutta*, *S. eriox*, *S. cambricus* (Sewin), *S. galivensis*, and so on, almost every British river having a variety or varieties peculiar to itself of one or more of these species. Their local names too are very numerous and equally perplexing. I knew a river in Argyllshire, the Edchaig, which enters the Holy Loch near Kilmun, and which during the month of June has a run of very fine *S. trutta*. These fish vary individually in weight from 1½ lbs to 5 or 6 lbs. Clear, silvery and fat, they are splendid fish for sport or for the table. Later on in August and September a smaller variety of *S. trutta* runs up this river, known locally as "blacknebs" from the dark colour of the head, these also are very excellent fish; while a few bull trout, or *S. eriox*, find their way up towards the end of the season. These different runs of fish all go locally under the designation of sea-trout. I might also mention Loch Lomond and its tributaries as being frequented by varieties of this species; for the streams flowing into the loch on the west side contain from June to the end of winter a variety of sea-trout between *S. trutta* and *S. eriox;* while the Endrick water, on the east side, has a breed closely resembling the true *S. trutta*, but which do not run up till August and September, during which latter month a number of salmon and grilse also go up to spawn. All these sea-trout lie in Loch Lomond for a time, and never ascend the streams which they prefer till a freshet or "spate" has come down.

So also with *S. fario*, the common trout. In the same water as above, Loch Lomond, I have recognized at least six different varieties. There are for instance the dark, almost black coloured, the brown, the golden and the silvery. Some are distinguished by having very large but very few spots; others by an ordinary number of black and red spots; a third variety by crowded round black spots and a few red ones; while the silvery kind has numerous black but no red spots. In Endrick water there are at least two

* Since writing the above I have seen a letter in "Forest and Stream," for July, 1880, by Professor Hind, of Nova Scotia, wherein for the first time the fact is disclosed that the male salmon breaks the hymen, or membrane enclosing the ova, by seizing the female behind the pectoral fins between his two jaws, when she rolls on to her side. May not the milt also be liberated through the males fighting?—W. A.

distinct varieties,—the clear silvery breed in the lower reaches, where the river is comparatively still, the water deep and the bottom sandy; and the golden breed in the upper waters, where the river tumbles over rocks, or ripples over coarse stones and gravel. The fins vary in colour, the belly fins are generally brown or olive, but sometimes of a golden tint, while occasionally the ventral and anal fins have a white anterior margin. Similar differences have been noticed in the trout of other waters, but I need not enlarge further, neither shall I attempt now to account for the many varieties of *S. salar*, *S. trutta*, and *S. fario*.

I have referred above to the limits within which the three best-known species of the genus *Salmo* are found. In connection with that I may mention that some years ago I met a Lieutenant Houston, of the United States Navy, who had been engaged on a surveying cruise along the coast of South America. He informed me that on the west coast of Patagonia he and his brother officers had caught and eaten trout. These were taken in a small stream, which ran out of a lake 4,000 feet above sea-level, and flowed into Smyth's Bay. While I do not question the good faith of this statement, I suspect that the fish may have been a charr, and do not think it could be the common trout, *S. fario*.

Acclimatized Salmonidæ.

The introduction into New Zealand waters of different species of the Salmonidæ from Great Britain, America, and Tasmania, which has been in progress during the last twelve years, renders the identification of these from one another a matter of some interest and importance. The circumstances of the culture of these fish in the colony are totally different from what they are in an old country like Britain, where the fish are indigenous. In England, Scotland, or Ireland the different species have their well-known and defined localities and seasons, so that, as a rule, when an example or specimen of a particular fish is wanted, it is known exactly where to go for it. But here in New Zealand, and more particularly as regards Otago, I find that, excepting the brown trout, we know as yet very little about the whence or the whither of the migratory Salmonidæ introduced from other countries. Thus, I would observe, no correct record appears to have been kept by which we can assert positively what English river contained the progenitors of our salmon put into Jacob's river as fry in 1874, 1876, and 1878. That is to say, although Mr. Howard, of Wallacetown, has informed me that the salmon ova came originally from the Tweed, Tyne, Ribble, Hodder, Lune, Avon, and Dart rivers, yet who can now say from which of these rivers the ova were taken which eventually hatched at the Wallacetown ponds? The Californian salmon introduced are supposed to be *S. quinnat*. Nor have I been able to trace the origin in England of the

young sea-trout liberated in Shag river by Mr. Young in 1871, only that the ova were got by Mr. Clifford in Tasmania from the Salmon Commissioners. This knowledge, though not essential to identification, would be interesting and useful in observing variations if such should occur through the difference of our rivers from the parent streams. And the more so if there be any truth in the report which Mr. Ellis, of Merrivale, heard in Riverton and communicated to me, viz., that during last summer young salmon were caught in the estuary of Jacob's river, and eaten by well-known inhabitants of the above town. As to this, I have to add that Mr. Howard went specially to Riverton to ascertain the truth of the above report, and he has assured me that he is not yet satisfied that it is so. Neither can the fact be decided until the fish seen has been caught and examined by some competent authority.

The English salmon and sea-trout, the American salmon (Californian) and the white-fish, are none of them natives of New Zealand waters, and it yet remains to be seen how they will succeed and how adapt themselves to our rivers. Excepting the sea-trout, we have no *proof* yet of the success of any of the others,—the young fry of all of which have been liberated in our rivers or lakes, some of them years ago.*

I will now proceed to describe certain specimens of migratory Salmonidæ as examined by me. With the assistance of the drawings of these fish which accompany this paper, I hope my descriptions may be the more readily understood. I need only add that I have made these drawings from the fish themselves by accurate measurements, laid down to life-size and afterwards reduced. In the case of the Sawyer's Bay *S. trutta* alone, the fish was only a short time in my possession, so that I did not get it so accurately delineated as the others. The head and fins, however, were retained by me, and made use of in the drawing which represents them.

Specimens examined.

1. *Salmo quinnat*, a smolt seventeen months old, hatched out with many others in November, 1877, at the Opoho breeding-ponds, Dunedin. It is now preserved in spirits, and is in the possesion of Mr. F. Deans. It is from ova obtained from California in 1877 as that of the *S. quinnat*, by the Colonial Government of New Zealand, and presented to the Otago Acclimatization Society.

General description: Colour,—iron or dark steel grey on head and back, passing into silvery on sides and belly; sides and gill-covers very silvery.

* It may be interesting to note here that in May, 1878, several hundreds of *S. salar* were caught running up the Connecticut river ten to fifteen pounds in weight, the result of fry planted there in May, 1874. Salmon have been extinct for three-quarters of a century in that river of the United States.—See report of Fish Commissioners of Canada, 1879.

Back fins, tail, and pectoral fins, dark steel grey, but lighter than the back; ventral and anal fins white. Round black spots plentiful along back, but few or none below lateral line, which is very distinct and raised; spots also on top of opercula and head; a few at base of dorsal fin and at base of tail. No red spots visible—par marks eight, still faintly visible, under the deciduous silvery scales.

In *form:* Head well developed, lower shorter than upper jaw and showing tendency to become hooked, upper jaw also hooked; maxillary long, drooping, and extending slightly behind the vertical from posterior margin of the orbit—it is also narrow, fine, and rounded at the end. Eye large, full, and black, with whitish yellow iris. Opercula well rounded or semicircular in margin. Preoperculum with a distinct lower limb, vertical margin at right angles to axis of fish and slightly sinuous. Suboperculum very large, larger than operculum, in shape nearly a perfect quadrant; junction of operculum and suboperculum forming an angle of 45° with axis of fish or with a vertical line. Body well filled out, outline of back slightly convex, body tapering towards tail; fins small relatively to body; tail very large and forked, spread $1\frac{3}{4}$ in.; longest caudal ray, $1\frac{4}{10}$ in., shortest, $\frac{4}{10}$ in.

Dimensions: Length from snout to extremity of tail, $7\frac{1}{10}$ in.; to origin of caudal rays, 6 in.; depth, $1\frac{4}{10}$ in.; girth, $3\frac{4}{10}$ in.; head, $1\frac{1}{2}$ in.; from snout to centre of eye, $\frac{11}{20}$ in.; eye to origin of dorsal, $2\frac{1}{4}$ in.; eye to origin of pectoral, $\frac{9}{10}$ in.; pectoral to origin of ventral, $1\frac{7}{10}$ in.; ventral to origin of anal, $1\frac{7}{10}$ in.

Fin rays: D.11, P.14, V.10, A.14, C.19.

Branchiostegous rays: 13 to 14.

Length of fins: D.$\frac{8}{10}$, P.$\frac{9}{10}$, V.$\frac{3}{4}$, A.$\frac{7}{10}$ in.

Teeth: Mandible, maxillary, head and body of vomer, palatines, and tongue all armed with teeth, those of mandible strongest and largest.

Scales: Deciduous, 17 in transverse row from adipose fin backwards to lateral line.

Of the same hatching with above specimen 13,000 young *S. quinnat* were reared, and then were put in the Kakanui river by Mr. Deans, manager of the Otago Acclimatization Society, in January, 1878.

Note.—The pyloric cæca of *S. quinnat* are 155 in number, according to Sir S. Wilson.

2. Columbia salmon, *Salmo paucidens* (?),—a salted specimen as imported into Dunedin from America.

General description: In *form*,—body of a fine handsome shape, well filled out; back finely arched, and hinder part of fish tapering off towards the tail; flank very deep, and fish fat; head inclined to be large, maxillary fine, broad and flat, projects $\frac{1}{5}$ in. beyond vertical from posterior margin of orbit;

premaxillary projects slightly over mandible. Opercula rounded in outline, margin of subopercular projecting beyond general outline of gill-covers, subopercular very large relative to the other opercula, and approaching a sector of a circle in shape; preopercular crescent-shaped, somewhat sinuous in outline, with a distinct rounded lower limb. Fins small relatively to size of body, tail very large and finely forked.

Colour: Head light brown, black back, sides and belly white, with faint pink or flesh tint on belly; bright strong silvery scales, rather large, all over the body. Dorsal fin brown, adipose blackish brown, pectoral white with black edge and tip; ventral and anal fins white; tail brown with black tip or margin. No spots visible anywhere. Lateral line distinct, but not raised or coloured. Flesh dark vermilion.

Dimensions: Weight 6 lbs. (before curing probably 7½ lbs.), length to origin of caudal fin, 21½ in., to fork, 23¼ in., total 24½ in.; depth 6 in.; girth 14 in.; head 5¼ in.; tail, width 5¾ in., longest ray 4 in., shortest 1½ in.

Fin rays: D.11, P.15, V.10, A.15, C.19.

Branchiostegous rays: 13. *Vertebræ:* 60.

Length of fins: D.2½, P.3¼, V.2½, A.2½ in.

Teeth: Very fine along body of vomer, on palatines and maxillary (head of vomer missing); coarser on tongue and on mandible, particularly towards the snout.

Scales: Bright, large and transparent, 15 to 16 in transverse row from adipose back to lateral line. L. lat. 140, L. trans. $\frac{20}{34}$.

NOTE.—Owing to tissues being somewhat decayed, the teeth and scales could not be correctly examined or enumerated.

3. *Salmo trutta.* This specimen was caught in the Frith of Clyde, and was sent to me preserved in spirits by an old friend and enthusiastic angler, Geo. Maclachlan, Esq. It reached me in November, 1878, by the "Timaru."

General description: A female, in fair condition, but evidently not come to maturity: back slightly arched, but shape of fish somewhat distorted by packing in a bottle; of a dark slate *colour* on back, passing into cream colour below the lateral line, and white on belly. The characteristic silvery scales present all over the body; the lateral line being black, distinct and raised, much more conspicuous and well defined than in any *S. fario.* Scales compared with those of common trout of same weight, and found to be only half the size and clear in colour, (scales of *S. fario* dark on posterior half). Black spots *x*-shaped, not numerous, and situated mostly above the lateral line; one round black spot on upper part of operculum; one or two indistinct on dorsal fin, none on adipose or tail. *Head:* finely shaped, one-fifth of extreme length of fish, small and sharp at the snout; maxillary flat and

fine, projects $\frac{1}{16}$ in. behind vertical from posterior margin of orbit, breadth one-sixth of extreme length from snout. Sub-operculum rounded in outline, preoperculum slightly sinuous, margin and lower limb distinct; tail forked. Fins, dorsal and pectoral dirty slate colour, with black on margin and in streaks; adipose and caudal black or nearly so; ventral and anal fins white; all small and fine as compared to size of fish; dorsal and tail with ragged and comb-like margins.

Dimensions: Weight, $1\frac{1}{2}$ lbs.; length, $15\frac{1}{12}$ in.; depth, 3 in.; girth, 8in.; head, 3 in. long.

Teeth: Remarkably fine and delicate, points like needles; two present and one gone on head of vomer, row along body of vomer; rows on palatines, maxillary and mandible.

Fin rays: D.11, P.13, V.9, A.10, C.19, with the usual 6 or 7 sub-rays at root of tail or caudal fin.

Length of fins: D.$1\frac{3}{4}$, P.2, V.$1\frac{6}{10}$, A.$1\frac{7}{10}$ in.

Scales: 16 in transverse row from adipose fin back to lateral line. L. lat. 138, L. trans. $\frac{22}{40}$.

Branchiostegous rays, 10. *Pyl. cæca* not examined, to avoid injuring fish.

4. *S. trutta.* A female, netted by Chinamen in Sawyer's Bay, Otago Harbour, April 27th, 1880.

General description: In *form*, a remarkably handsome fish; very fat, deep in the flank, and so full in body as to dwarf in appearance the tail and fins. Back arched; head very small, fine and clean cut, only one-fifth the extreme length of fish; dorsal and caudal fins ragged and comb-like in margin; caudal fin slightly forked. *Colour:* Steel grey, with blue tint on head and back, white sides and pure white belly; bright silver coating of deciduous and characteristic scales over the whole body—except where rubbed off. Lateral line distinct and raised. Dorsal, adipose, and caudal fins light blueish black. Pectoral white, with blue-black streaks; ventral, white; anal white, with light-bluish streaks in middle. A good deal of steel-blue colour about head and along scales on back. *Spots:* A few black ones, *x*-shaped, situated above and below lateral line; two round ones on gill-covers; a few on posterior part of dorsal fin, but none on adipose or tail; no red spots. *Head:* Silvery in colour, and small in size. Eye, small and round; pupil, black; iris, olive-coloured. Maxillary fine, broad and flat; projects very slightly behind vertical from posterior margin of orbit. Mandible slightly longer than maxillary, and inclined to project into a hook. Opercula rounded in margin. Suboperculum nearly a sector of a circle. Preoperculum slightly sinuous in margin. Lower limb not defined. *Contents of stomach:* A small quantity of white mucus only. Roe-lobes very small, just about 1 to $1\frac{1}{2}$ inches

long. Ova, about the size of small pin-heads or turnip seed. Flesh, of a pale pink colour. When cooked, this fish ate much finer than any brown trout which I have tasted in Otago.

Dimensions: Weight, 2 lbs. 14 oz.; length, 17½ in.; depth, $4\frac{6}{10}$ in.; girth, 11¼ in.; head, 3½ in. long.

Teeth: Very fine on maxillary, palatines, and vomer. On head of vomer two, and one rudimentary. None at all along body of this bone. On mandible and tongue not so fine, coarser.

Fin rays: D.11, P.13, V.9, A.10, C.19; 5 sub-rays above and 5 under origin of tail, as usual. Length of rays, D.2, P.$2\frac{3}{10}$, V.$1\frac{9}{10}$, A.$2\frac{4}{10}$ in.

Scales: 15 in transverse row, from adipose back to lateral line.

Branchiostegal rays: 10. *Pyloric cæca*, 40; surrounded by much fat.

5. *S. cambricus.*—A Welsh sea-trout, from the river Usk. This is one of three specimens (smolt stage) preserved in spirits, in the Otago Museum.

General description: This specimen is discoloured, owing to the action of the spirits in which it is preserved, in common with but not so bad as the other two. In *form:* Rounded outline, but not very full or deep in the body; thickness maintained towards the tail. Head contained 4½ times in extreme length of fish; snout rounded; jaws of equal length; maxillary, broad and fine; posterior end accurately circular, and does not project beyond vertical from posterior margin of orbit. Operculum large, hind margin straight, and forms right angle with lower margin. Suboperculum narrow, longer than broad, of rectangular form, but with the posterior angle very circular, and projects behind the operculum. Preoperculum with a rounded outline; lower limb not distinct. Eye large and round. Fins average size. Tail forked. *Colour:* Brown back, silvery sides; scales deciduous; white belly; par marks, ten, faintly visible. Spots black, round, and numerous on gill-covers and body above and below lateral line (which is distinct but not prominent). Dorsal fin spotted; three spots on adipose; tail immaculate. So far as can be made out, dorsal fins and tail dark; pectoral, neutral, and anal fins white.

Dimensions: 7⅛ in. snout to tip of tail; head, $1\frac{6}{10}$ in.; other dimensions proportional.

Teeth: Fine, present on mandible, maxillary, and palatines; vomer, crescent-shaped; head armed with a few teeth, shaft of bone with two distinct rows along outer edges.

Fin rays: D.11, P.13, V.8, A.9, C.19, with the usual four or five sub-rays above and below.

Scales: 15 in transverse row from adipose back to lateral line.

Branchiostegal rays: 11. The pyl. cæca and vertebræ not examined.

The other two specimens *(S. cambricus)* differ from above in the ventral fins having 9 rays, and in having no spots on the adipose fins.

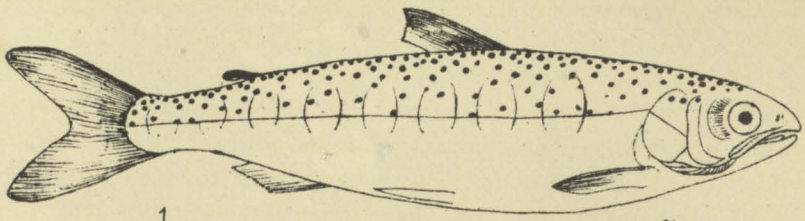
Remarks suggested by above specimens examined.

Salmo quinnat:—In the absence of a specimen of the mature fish, the above description of the smolt may serve as an approximate guide to identification of this species when it may be met with in our waters. The adult will probably be found to have fewer vomerine teeth, and to be fuller in body or "thick" as stated by Mr. Lord—the silvery scales also will be more permanent. The only descriptions of this fish accessible to me, are those by Dr. Günther, Mr. Lord, and a letter from Dr. Comrie, R.N., written from Vancouver Island, and now in my possession. These are anything but complete, with the exception of Mr. Lord's. Dr. Günther classes this salmon under the genus *Oncorynchus,* in which the anal rays exceed 14, and he calls it a "migratory trout from the Columbia river." The two other authorities I have named call it a salmon, and speak of it as ascending the Columbia and Fraser rivers, sometimes attaining the great weight of 75 lbs.—the average weight being 25 lbs. The only migratory trout referred to by Mr. Lord is *S. spectabilis* or the *S. campbelli* of Günther. The specimen examined by Dr. Günther may possibly have been accidentally labelled in error, as certain others were which he mentions in his catalogue. As to the number of anal rays, it will be seen that I found just 14 in this smolt, and I would explain that by assuming that this young salmon resembles other species of the Salmonidæ wherein a reduced number is not uncommon in young fish, such, for example, as in the *S. cambricus* described above in this paper.

The *S. quinnat* is proved to be capable of living and breeding in freshwater rivers when cut off from all access to the sea; but that it can continue indefinitely to thrive and propagate, is not thereby determined as yet. It seems also that the grilse in an open river do not breed for several years, and probably not until they become mature fish. Their journeys up the rivers of North Western America, are in distance and duration also regulated by age and the condition of the water. Very young fish only ascend a short way and then come back again to salt water. No runs of fish take place during floods, but only when the flow of water is steady, irrespective of its being high or low.*

I may observe here that Dr. Günther has described at least four species of the genus *Oncorynchus* as frequenting the rivers of North Western America, and probably there are several more species of this salmon which have not come under his notice. But it is interesting to observe that this genus is numerous in species and capable at the same time of great modification in habits; while the *S. salar* of British waters is the only species

* App. to Jour. H. of R., 1878.



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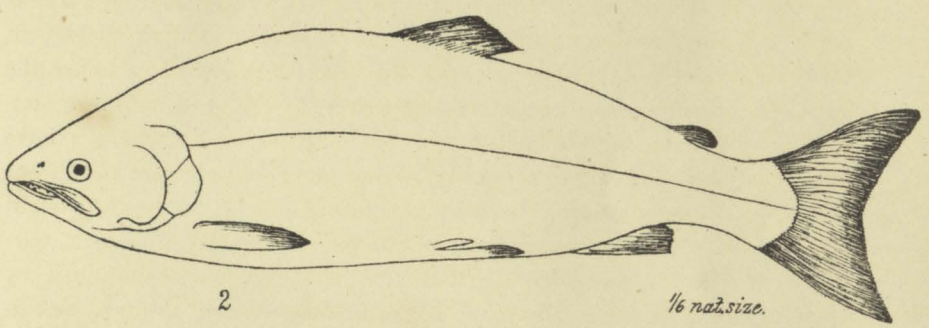

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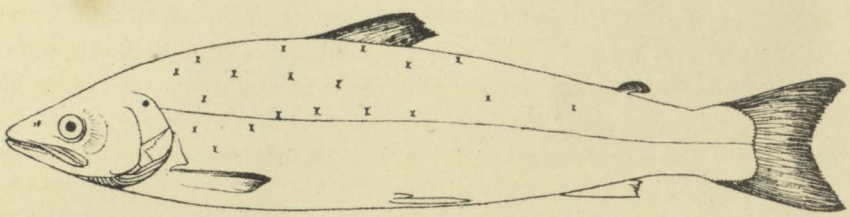

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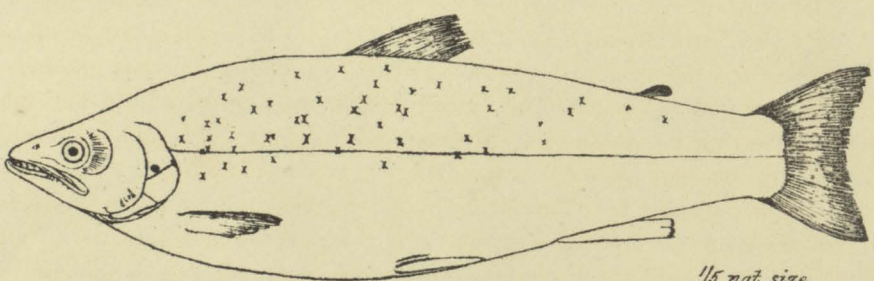

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SALMONIDÆ.

W. Arthur, Del.

of the true salmon we have in these waters, and it refuses to thrive and propagate when cut off from the sea. Stoddart gives a striking instance of this latter fact in his "Angler's Companion to the Lakes and Rivers of Scotland."

The *habits* of the *quinnat* so far as I can find them to have been observed during the past, may be described as follows:—In the short coast-rivers they spawn in January and February. In the large rivers of North-western America, which spring from the Rocky Mountains and other Sierras, they spawn from June to September. The young fish descend to the sea from these interior streams with the floods consequent on the melting of the snow by the summer heat of the following year or season. They appear then to remain in the sea and estuaries for several years, the grilse running up the rivers a certain distance and then going back to the sea without spawning. These journeys seem to become longer as the fish approaches maturity, until the third or fourth year, when the female is in spawning condition. After spawning (which the female only accomplishes once), she dies, and but a small proportion of the males ever get back to the sea, as I shall presently show more fully. The very largest fish occasionally caught, are males, supposed to have survived several trips up the rivers, and to have attained their great weight during their residence in salt water.

This salmon may be caught with bait or spinning-lures in the estuaries or bays on the coast; but in the rivers they refuse artificial or natural flies and baits of all kinds, excepting occasionally pieces of their own roe. They never feed in the rivers.

Some species of Californian salmon spawn every year, others every alternate year.

The *quinnat* lives in rivers of California where the temperature of the water has been found in August to rise as high as 84° Fahr. The English salmon prefers cold, clear waters, and probably would die in water of so high a temperature.

As to the economic value of this salmon, it seems to me to be more than doubtful. The following quotations I give from several authorities possessing more or less information:—

"Soon after commencing work I was encamped for many months on the banks of the Chilukweyuk River, a tributary of the Fraser. About a mile from my camp was a large patch of pebbly ground, dry even at the highest floods, through which a shallow stream found its way into the larger river. Though barely of sufficient depth to cover an ordinary sized salmon, yet I have seen that stream so filled that fish pushed one another out of the water high-and-dry upon the pebbles. * * * It seems to me that thousands of salmon ascending these small mountain streams never can

spawn from sheer want of room. * * * At the end of the pebble stream was a waterfall, beyond which no fish could by any possibility pass. Having arrived at this barrier to all further progress, there they obstinately remained. Weeks were spent in watching them, but I never, in a single instance, saw one turn back and endeavour to seek a more congenial water-course; but, crowded from behind by fresh arrivals, they died by the score, and drifting slowly along in time reached the larger stream. It was a strange and novel sight to see three moving lines of fish—the dead and dying in the eddies and slack water along the banks; the living breasting the current in the centre, blindly pressing on to perish like their kindred.

"Even in streams where a successful deposition of the ova has been accomplished, there never appears, as far as my observations have gone, any disposition in the parent fish to return to the sea. Their instinct still prompts them to keep swimming up-stream, until you often find them with their noses quite worn off, their heads bruised and battered, fins and tail ragged and torn, bodies emaciated, thin, and flabby; the bright silvery tints dull and leaden in hue, a livid red streak extending along each side from head to tail, in which large ulcerous sores have eaten into the very vitals.

"The Indians say all the salmon that come up to spawn die; but if all do not die, I have no hesitation in saying that very few spring salmon ever reach the salt water after ascending the rivers to spawn." *

"Having killed and eaten salmon in almost every part of the world they inhabit, California included, I hope I shall not be considered presumptuous in giving a tolerably decided opinion as to their relative merits, and have no hesitation in saying that the best breed of salmon I have ever met with is our own, and the worst the Californian. * * * But another and most serious objection to their being brought over here should be considered, viz., the fearful prevalence of disease among them. The mortality among salmon in California is simply incredible. I have seen many thousands of them dead and dying from apparently a fearful leprosy." †

"Mr. Livingston Stone, Dep. U.S. Fish Commissioner, in charge of the Government hatching establishment on the McCloud River, reports officially that, in his opinion, all of the salmon of that river die after depositing their spawn. This is possibly true, but it does not account for the fact that in the spawning season the McCloud contains grilse and fish evidently of three, four, and five years old, unless we are to imagine that some salmon, after being hatched and going to the ocean, remain there two, three or more years without returning to the parent stream for purposes of spawning. * * * From the letter of a fisherman, he says,—'As to the return

* "The Naturalist in British Columbia," by J. Keast Lord, 1866.

† Article in "Fishing Gazette," London, 1879, by Sir Rose Price.

of the seed salmon to the sea after depositing the spawn, I am inclined to the opinion of Mr. Stone, so far as the greater part of the female fish are concerned. I think very few of these, but many, though not all of the males, return. I should judge that five per cent. of females and twenty per cent. of males might be an approximation. I express this opinion diffidently. * * * * The female salmon seldom or never spawns but once.' "*

"*Fraser River Salmon:* The general opinion exists that these salmon die after spawning, prior to their return to the sea. My convictions are that this opinion, although strongly defended, is entirely an erroneous one, not supported by sufficient data or proof to establish its correctness. I am free to admit that a large number of salmon never return to the sea, and indeed the immense number found dead and in a dying condition in so many streams, is an abundant evidence of this fact; but I contend that this circumstance is simply and wholly the result of natural causes, and not owing in the slightest degree to any inability to return to salt water. * * * * *Salmo quinnat* has never been seen in the Fraser, nor a suck-eye in the Columbia. Some varieties spawn each year, others every alternate one."†

Although the two latter quotations are from articles written in defence of Californian salmon, the *S. quinnat* included, they bear out the fact, so graphically stated by Mr. Lord, as to the dreadful and loathsome mortality among the spawning fish; there can be no doubt, therefore, that the *S. quinnat* is a most undesirable fish for our New Zealand rivers, and particularly for such rivers as are stocked with trout. The whole article in "Forest and Stream" from which I have taken the above extract, loses much of its interest and value from the loose nature of some of its statements. For example, the first sentence quoted above, is a contradiction in terms, and the description given of the death of the salmon through exhaustion, shows by the writer's own words, a very decided lack of "ability to return to salt water" at all! The "suck-eye" mentioned, is I believe the *S. paucidens* of Günther and Lord. Both Mr. Lord and Dr. Comrie describe the *S. quinnat* as an inhabitant of the Fraser river, and Mr. Lord, together with Dr. Günther, reports *S. paucidens* as going up the Columbia river, so that, so far as I can find, the balance of evidence on these points is against the writers in "Forest and Stream."

The *S. paucidens* (?) has been so named by me because I cannot find any other described species to agree so well with the marks of this specimen. At the same time it differs from the fish noticed by Dr. Günther and Mr. Lord, in that its back is not straight but highly arched, and it is greater in

* New Zealand Parliamentary papers, Californian salmon and whitefish ova, 1878.

† "Forest and Stream," New York, 17th June, 1880.

weight than the average (3 to 5 lbs.) which they mention. Dr. Comrie, however, writes that *S. paucidens* runs from 5 to 6 lbs. and has a maximum weight of 10 lbs. The teeth of this, the "weak-toothed" salmon, were not easily found by me in the vomer and palatines of above specimen, possibly on account of the "curing" of the fish. Possibly also the arched back may be due to packing into small barrels. As they appear in the Dunedin market, these fish are all as nearly as possible of the same weight, 6 to 7 lbs.; whether this is accidental or not, I have not means at present of determining. As food they are excellent.

This fish, as well as the *S. quinnat,* among other things differs remarkably from the *S. salar* of British rivers in the size and shape of the subopereulum, which is very large relatively to the operculum and has a rounded margin which, with the two joints, forms a figure approaching a sector of a circle. This *S. paucidens* likewise has no spots anywhere, and the same may be said of several other specimens I have looked at of the same fish. The tail also is very large and forked.

The *S. trutta* from the Clyde, and which may now be seen in the Otago Museum, I have compared with Dr. Günther's description of four specimens from the river Tweed, varying in length from 18½ inches to 35 inches. The relative length of the head to the body and the depth relatively to length of body, without the caudal, agreed very well; but all the fins of the Clyde fish are larger than those of the Tweed sea-trout. The fin-rays of the Clyde specimen are fewer by one or two—in the dorsal, pectoral, and anal fins—than those given by Dr. Günther; the ventral being the same in the number of rays. But they agree almost exactly with those given by Yarrell. The gill-covers in form and the colours of the body fins agree with the descriptions of those by Günther and Yarrell. The difference in the number of fin-rays from those given by Günther is apparent rather than actual, as the latter seems to have included the rudimentary or sub-rays, which I have omitted. The vomerine teeth differ also in being nearly all present in this Clyde specimen, while in the Tweed specimens of Dr. Günther they are only present in small numbers on head of vomer. The fish, which undoubtedly is a sea-trout, is evidently not a mature fish or rather not come to its full growth. Its general appearance suggests this in the want of fullness of body, while the size of the tail and head and presence of so many vomerine teeth confirm the supposition.

The sea-trout from Sawyer's Bay agrees in most of its markings with the Clyde one described above, also with Günther's and Yarrell's fish. It is also identical with the stuffed *S. trutta* in the Otago museum, taken at Otago Heads in 1874. That is to say, it has the correct and liberal coating of bright silvery scales, the gill-covers are silvery, the back and all the fins

bluish black or white, the spots not numerous, black and *x*-shaped, the gill-covers rounded and proportioned accurately or nearly so, maxillary fine, and teeth comparatively fine, those on the vomer only present on head of this bone. The Clyde *S. trutta*, the *S. trutta* in the museum, and this fish all agree very closely in the size of the fins relatively to length of body, and these are all smaller relatively than in such examples of *S. fario* in Otago as I have yet examined.

But, on the other hand, it differs from the typical *S. trutta* and from *S. fario*, in that the lower jaw projects very decidedly beyond the upper one, even though it be a female, and when the mouth is shut it is just the same. This mark is the same in all the other individuals (three or four) which I have known caught in Otago Harbour, and which I have seen. Curiously enough a trout caught in Lake Wakatipu, by Mr. J. P. Maitland, in the beginning of this year, of about 1½lbs. in weight, had a head identical with this *S. trutta*. It also had no spots on its body, which was covered with brilliant silvery scales, and only two dark round spots on the left gill-cover. But the vomerine teeth were complete, excepting on the head of the vomer, which was toothless. It is only fair that I should state this, because no sea-trout were ever liberated in any tributaries of the Wakatipu, which is 200 miles from the sea, nor in any feeder of the Clutha River; and, also, because some people who take an interest in this subject are in doubt as to whether we have the *S. trutta* in Otago at all or not.

There is just one other fact I must mention particularly about this Sawyer's Bay sea-trout, which is, the smallness of the ova, only the size of pin-heads, and the whole lobes not more than an inch and a-half long. This is an extraordinary condition for a migratory trout, or any trout, to be in during April, which corresponds to October in England—when sea-trout begin to spawn. At the same time, I must not omit to observe that large females of this same species caught in the harbour in November are often full of large ova almost ripe, the fish themselves being in splendid condition. November in New Zealand corresponds to May at home.* These two facts, and also this, that no undoubted sea-trout has yet been taken in any of our rivers, may mean much, but what the meaning may be it would be premature as yet to decide. Do these fish spawn during the same month of the year as at home, and is the spawning effected in the little streams entering Otago harbour in every little bay, or do they spawn in the tidal way of the harbour itself? If in the small streams, we should most likely during the

* Californian salmon, which in a state of nature spawned in January and February, in the head waters of coast rivers, have been found to spawn in September when cut off from the sea and confined to short coast streams.—(App. to Journ. H. of R., 1878.) W. A.

six years these fish have now been in our harbour, have seen or heard of the young fry being in these streams, but we have not. Such a thing as a sea-trout spawning in salt water is unknown, and it will be very surprising if our *S. trutta* are found so to do. There is thus a mystery as to the habits and movements of our *S. trutta*, sufficient almost to throw doubt on their identity. Still we are in this position—we have a trout got only in the salt water, specifically differing from the common trout of our streams, and agreeing in its distinguishing marks with *S. trutta*. It is caught in the salt water varying in weight from 1 lb. to 18 lbs., and is often found in spawning condition in the beginning of our summer. Hitherto no well verified example has been taken in any of our streams. Much remains, therefore, to be discovered of the habits in our waters of this fish, which I do not doubt, after the examinations I have made, is the real *Salmo trutta*.

The sea-trout of Otago were brought from Tasmania as ova by Mr. Clifford, 137 young fish being turned into Shag river in 1871, at which time also I understand a few more were put into the Water of Leith, at Duncan's mill.

Distinguishing Marks.

These marks, I will endeavour, in closing this paper, to summarize briefly; and in doing so I may say that I give them partly from my own observations, and partly as I find them given by the best authorities. They refer only to adult fish.

Of the *S. quinnat* and *S. paucidens*, I cannot venture to lay down from my own experience rules for their identification from other salmon of the same genus, the *Oncorynchus*, as my knowledge of these fish is as yet very limited. It would require years of residence and study in California or Columbia to acquire such knowledge correctly, and as yet I have not been able to find any author who gives a full and accurate description of these fish. At the same time there is no difficulty in recognizing the difference between these and the *Salmo salar*. They belong to a different genus, the *Oncorynchus*, where the anal rays exceed 14, while in the *S. salar* these are always less, being rarely more than 10.*

But of the *S. salar* I may say that it may be most readily distinguished from the other species (*S. trutta* and *S. fario*) of the genus *Salmo*, by its strong and uniform coating of burnished silvery scales, 12 in transverse row from adipose to lateral line; its fine sharp and clean-cut head; its arched back and deep belly, its taper and cylindrical shape towards the tail, its large square tail, sometimes emarginate; by the fewness, and x-shape of its

* Mr. Lord describes the margin of the operculum as having spinous projections which give it a serrated form.

black spots, the absence of spots on the fins, and the colour of the fins, the dorsal, adipose, and tail being black, and the pectoral, ventral, and anal white, with more or less dusky shading; the form and proportions of the gill-covers, and the deciduousness of the vomerine teeth—these teeth being fewer than in *S. trutta*.

The salmon also attains a much greater weight than the sea-trout, and its anal fin appears to be smaller in proportion to whole length of the body than in *S. trutta* and *S. fario*. Comparing a number of Günther's specimens of *S. trutta* and *S. fario* with three of *S. salar*, in regard to this proportion of the anal fin, I find in the two former the ratio is as 1 to 12, while in the latter it is as 1 to 16. (See table appended to this paper. Refer also to drawings of gill-covers.)

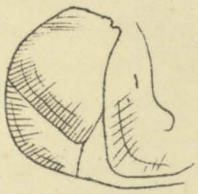
The *S. trutta* is a shorter fish for equal weights than the *salar*, and it is deeper or thicker at the origin of the tail; the tail is generally square. The colour of the back is darker, and the silvery scales (15 to 16 in transverse row) more deciduous than in *S. salar;* the spots are more numerous, but of the same colour and shape, and there are usually a few present on the posterior part of the dorsal fin. The fins are similar in colour to those of the *salar*, the belly fins being rather whiter. The gill-covers differ to some extent, the lower limb of the preoperculum being rounded and not so angular, and the vomerine teeth are longer present than in *S. salar;* also the fins are longer, particularly the anal fin.

The *S. fario* may be generally distinguished from the two preceding species by its olive-brown colour, round black spots, and its crimson spots. But the same variety alters in colour according to sex, age, season, food, and water. I find this so with our Otago-bred trout, from which my comparisons are mostly taken, just as many observers have at home in the fish of English rivers. (Since beginning this paper, I have had several excellent opportunities of again seeing our breeding-fish in spawning condition in the Acclimatization Society's pond. The males, and more especially the largest from 8 lbs. to 10 lbs., are in colour a brown-yellow with a pink tinge in the body, the back-fins and tail very pink, and the spots black and red, very distinct; the hook on mandible very large. Even the females, which were silvery, had all pink-tipped adipose fins and faint red spots in some cases above and below the lateral line. To-day, 11th August, I saw and handled a number of these splendid trout from 3 lbs. to 8 lbs. in weight). Some of our streams too have tidal estuaries, and the large trout which are believed to visit the tidal water will, no doubt, acquire a more silvery hue than those which do not. This tends to complicate the distinctions still more, and to make it more difficult to detect the difference between these and the true sea-trout. Yet, so far as my examinations have enabled me to judge, I find

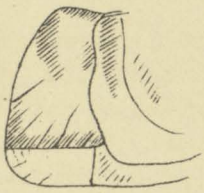
that no matter how silvery the common trout may have become, its dorsal fin has always a good number of round black spots arranged in rows; the adipose is brown with more or less of pink round the margin, it also has nearly always two or three dark spots; the pectoral, ventral, and anal fins are always brown or olive-yellow, occasionally the ventral and anal have a white margin along the longest ray. The maxillary is coarser and generally longer, the suboperculum is somewhat four-sided, with the posterior angle more decided than in *S. trutta* in which it is circular, but this character varies a good deal. The teeth are coarser, and those of the vomer much more permanent than in the sea-trout. I have frequently in old and large fish found them not only on the head but well back along the shaft of that bone. I have also found the fins coarser and larger relatively to length of body, and covered with thicker skin than in the two preceding species. Scales 14 to 17 in transverse row from adipose fin to lateral line. *S. fario* like *S. trutta* is thicker at origin of tail than *S. salar*. In doubtful cases I have noticed that the head when kept for a week assumed the normal brown colour of the common trout, while the heads of such as I believed to be sea-trout retained their silvery hue.

In the three species, *S. salar*, *S. trutta*, and *S. fario*, I do not believe any dependence can be placed on the numbers of fin rays, vertebræ, or even pyloric cæca (excepting in the case of *S. levenensis*), as a means of distinguishing the one species from the other. Still these have their place and their value, and when any doubt arises as to the identity of any particular Salmonoid, its removal should be the result of a careful consideration of all the invariable distinguishing marks, together with that of such also as are not invariable or not essential.

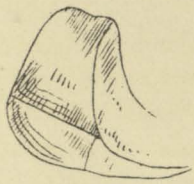
I append a table, the investigation of which will bear out generally my observations on the difference in the size of the fins, as also on the ratio of the least depth of the tail to the whole length of the fish.



S. Salar



S. Eriox



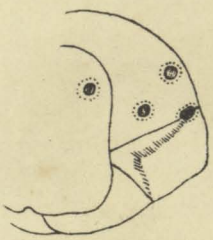
S. Trutta

S. Quinnat
(smolt, nat: size.)

S. Paucidens (?)
1/3 nat: size.

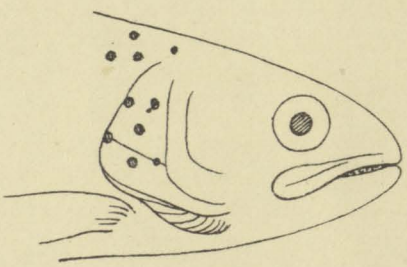
S. Trutta
Clyde.)

S. Trutta
(Otago.)



S. Fario
(Otago)

(1/2 natural size.)



S. Cambricus, Smolt.

TABLE showing the Ratio of Length of Fins, and of least Depth of Tail to the Total Length of the Fish.

l is length of fish; *d*, least depth of tail; *D*, *P*, *V*, *A*, the various fins.

DESCRIPTION OF FISH.		PROPORTIONS OF EACH FISH.					MEANS.				
		$\frac{l}{D}$	$\frac{l}{P}$	$\frac{l}{V}$	$\frac{l}{A}$	$\frac{l}{d}$	$\frac{l}{D}$	$\frac{l}{P}$	$\frac{l}{V}$	$\frac{l}{A}$	$\frac{l}{d}$
S. salar—											
Male, 46 inches	Described by Dr. Günther.	10·00	8·36	10·00	13·81	13·81					
Male, 36½ inches		10·08	8·11	9·73	18·25	14·60					
Male, 22 inches		10·37	8·39	10·37	16·06	12·57					
Male, 38⅝ inches, R. Usk... ...	Casts from Buckland.	9·00	8·68	10·61	10·91	14·68	9·39	8·65	10·38	13·29	13·87
Female, 41$\frac{3}{10}$ inches		8·26	9·38	10·87	10·32	14·75					
Female, 30¼ inches		8·64	...	...	10·43	13·44					
S. quinnat—											
(Smolt), 7$\frac{1}{10}$ inches	Described by W. Arthur.	8·87	7·88	9·46	11·83	14·2	8·87	7·88	9·46	11·83	14·2
S. paucidens (?)—											
24 inches		12·00	7·38	9·60	9·60	...	10·90	7·45	9·70	9·70	12·25
24½ inches		9·80	7·53	9·80	9·80	12·25					
S. trutta—											
Male, 35 inches	Described by Dr. Günther.	11·66	8·23	10·76	12·72	11·66					
Female, 27¾ inches		9·63	9·63	11·70	12·33	13·09					
Male, 18½ inches		9·89	8·72	11·42	12·33	12·33					
Male, 24 inches *(S. cambr.)* ...		9·60	8·86	10·12	12·83	12·83	9·24	8·20	10·68	10.70	12·35
Female, 22½ inches *(S. cambr.)*		10·00	8·18	9·49	12·03	12·85					
Cast by F. Buckland, 24½ inches		8·16	8·16	12·24	9·07	11·62					
Female (Clyde R.). 15$\frac{1}{12}$ inches	Described by W. Arthur.	8·62	7·54	9·42	8·87	12·58					
Female, Otago, 1874, 15½ inches		8·85	8·85	10·33	7·75	11·07	8·80	8·22	9·77	7·52	10·68
Female, Otago, 1880, 17½ inches		8·75	7·60	9·21	7·29	10·30					
S. eriox—											
Male, 20 inches, Dr. Günther ...		10·70	8·88	11·42	12·34	13·33	10·71	8·46	10·31	10·52	12·0
Cast from F. Buckland, 32$\frac{2}{10}$ in.		10·73	8·05	9·20	8·70	10·73					
S. fario—											
Male, 10⅜ inches	Described by Dr. Günther.	10·37	6·40	8·78	13·82	11·95					
Male, 28½ inches		10·36	7·12	8·30	8·14	12·66					
Male, 16 inches		9·13	7·54	8·83	11·68	11·68					
Male, 20 inches		10·00	7·63	9·43	12·34	13·33	9·29	7·42	9·16	9·86	12·12
Male, 29¾ inches, Shag R. ...	Described by W. Arthur.	9·15	7·44	9·91	8·50	11·90					
Female, 29¾ inches, Shag R. ...		7·82	7·44	9.15	7·44	12·35					
Female, 17½ inches, Leith ...		8·75	7·60	8·75	8·75	..					
Female, 33 inches, J. Wilson ...		8·80	8·25	10·15	8·25	11·00					

EXPLANATION.—10·00 in column *l*-D means whole fish is ten times the length of dorsal fin, and so on; or dorsal fin is $\frac{1}{10}$ the total length of fish.